Commercial Pine Plantations Negatively Impact Biodiversity and Wetland Functionality at Lower Tokai Park

Matric Geography Project
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Constantia Waldorf School

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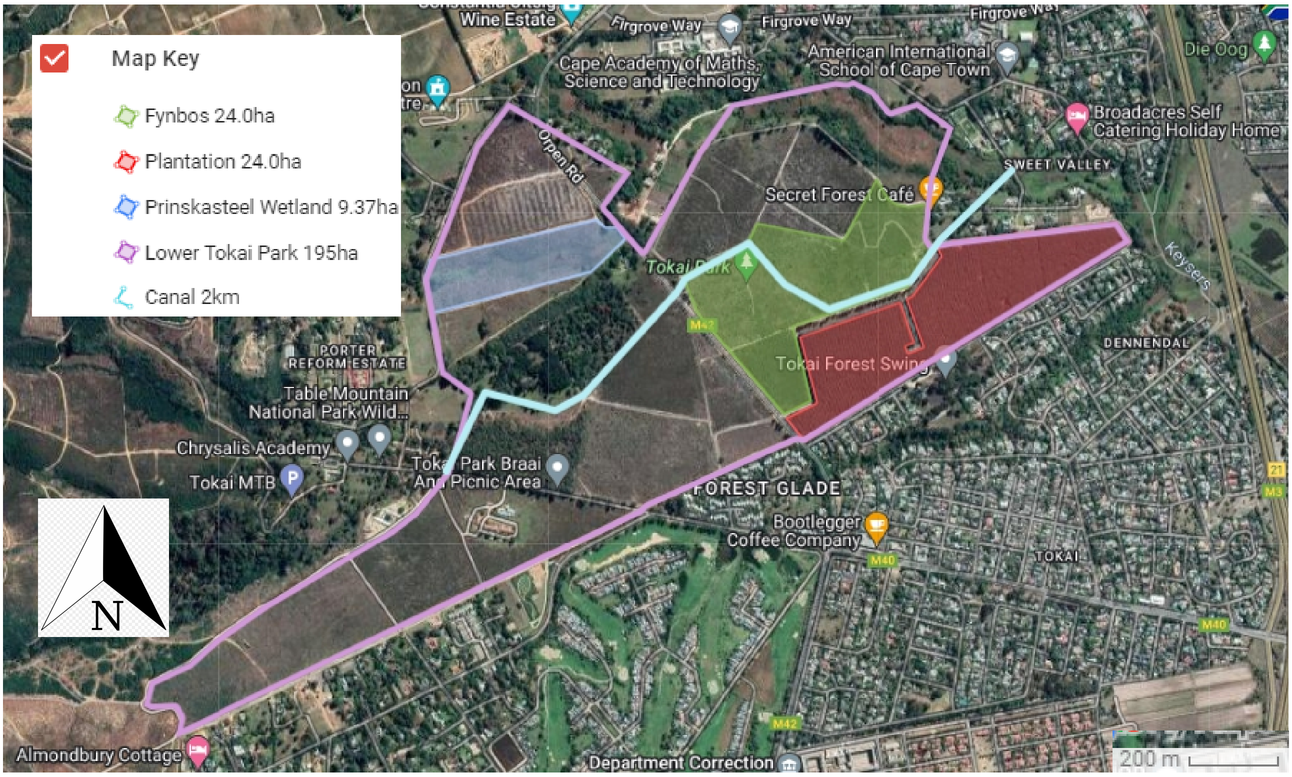
Hypothesis:

Commercial pine plantations negatively impact biodiversity and wetland functionality at Lower Tokai Park

Maps & Mapping:



- Fig. 1: Lower Tokai Park study area map (key, compass, & scale included)

Background Information:

Lower Tokai Park is a 195ha nature reserve with a Mediterranean-type climate. It is situated in Tokai in Cape Town, South Africa at Latitude: 34° 03' 17" S. and Longitude: 18° 25' 59" E. It is currently governed by South African National Parks (SANParks).

A pristine periodic river or canal runs through the centre of the reserve. This canal is directly fed by run-off water from the Constantiaberg Mountains just to the West of the reserve. In addition to this, the reserve is home to multiple wetlands fed mostly by underground seeps where not in contact with the canal. Perhaps, most significant is the Prinskasteel Wetland which makes up approximately 9.37ha [Fig. 1].

In the early 1900's Monterey Pine *(Pinus radiata)* plantations were established at Tokai and so the reserve has been covered in commercial plantations for over a century; seeing through a total of three harvest cycles [FOTP 2018].

Under novel post-Apartheid management by SANParks, the area was designated as a core conservation site [Van Rooyen 2015]. Most of the plantations at Lower Tokai Park have since been removed. However, in the southeastern-most corner of the reserve, approximately 24ha of Pines still remain. As the park is surrounded by suburbia to the North, East, and South; the future of this last stand of Pines has been the centre of controversy for several years already [Peters 2016].

Given Tokai Parks' location, climate, and geomorphology; the dominant vegetation type occurring within its borders is Cape Flats Sand Fynbos (CFSF). Only 14% of this vegetation type still remains, with less than 1% actively conserved; hence its classification as Critically Endangered. As a result, as many as 150 CFSF species found in the reserve are threatened with extinction [City of Cape Town 2011] [Fig. 8]. While environmental conservationists and scientists alike have been pushing for the removal of the Pines and subsequent restoration of the local Fynbos for many years now, residents continue to protest against this in the name of shade for their own recreational activities.

Data Collection Process:

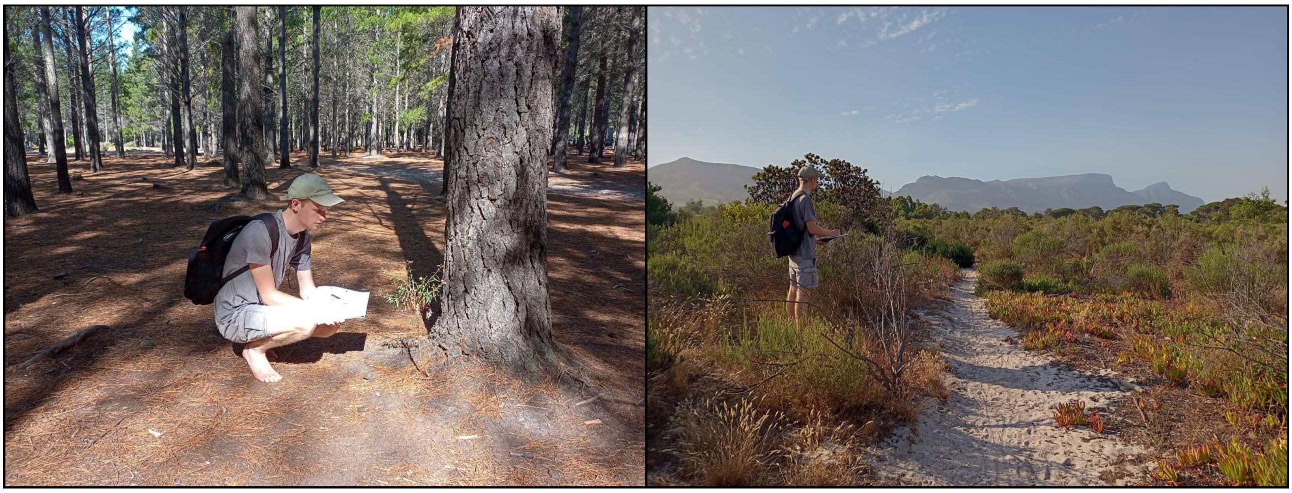
For the duration of the project I conducted surveys through field trips that monitored species diversity on two plots of the same amount of land (24.0ha each) at Lower Tokai Park. One plot was under Pine plantation while the other adjacent plot consisted of the natural Fynbos.

Similar surveys were organised by the Friends of Tokai Park (FOTP) between 2019 and 2022. This relied on volunteers (including myself) to document the reserves' fauna and flora [Constantiaberg Bulletin 2019]. This form of secondary data was extracted from iNaturalist*. I then added my own primary data (observations and complimentary photographs) to this additional data collected by both scientists and volunteers. This allowed the project to express only the most meticulous results. This data was then synthesised into graphs for easier understanding (see: *'Data Analysis and Synthesis'*) [Fig. 3-5].

I went on to interview Professor Tony Rebelo from the South African National Biodiversity Institute (SANBI) regarding his observations of the Prinskasteel Wetland (9.37ha) over the years. Prof. Rebelo has worked at Lower Tokai Park for many years and has great experience in studying its ecology. A copy of this interview addendum is attached at the end.

Additional secondary data is also included under the *'Data Analysis and Synthesis'* section. This consists of both government and non-government published research studies and statistics, as well as news articles highlighting the conflict between Tokai residents and scientists (one such article is attached at the end for viewing).

*iNaturalist is a social network designed for naturalists, biologists, and citizen scientists to upload their own photographic or audio observations of species to assist in species mapping.



- Fig. 2: Collecting primary data in the Tokai plantation and adjacent Fynbos

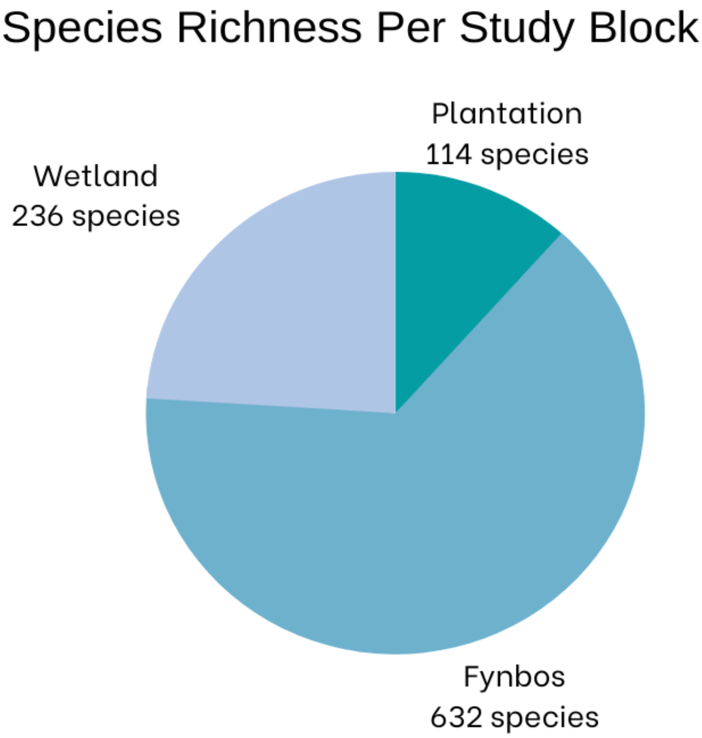
Data Analysis & Synthesis:

My surveys found that under the 24.0ha Pine area, a mere 114 species could be found. On the other hand, an astounding 632 species were recorded in the adjacent 24.0ha Fynbos area. This adds up to over 500 more species in the same amount of space; over five times more species occur in the Fynbos than in the plantation. Moreover, the vast majority of species under the plantation were alien weeds and not actually indigenous Fynbos species.

However, 236 species were recorded in the 9.37ha Prinkasteel Wetland. Although the wetland has significantly less species than the Fynbos block, it also covers a much smaller area. When taking this in account, I found that the area is actually almost just as biodiverse as the Fynbos block. This was not that case for the Pine plantation block, which only has a fraction of the number of species [Fig. 4].

The species data or list of all species recorded for the project is attached at the end. This list includes (in order) each observation or record reference number, the specific location information (accurate to the block), and GPS longitude and latitude coordinates of the observation. It also lists the scientific name of the species as well any common name/s.

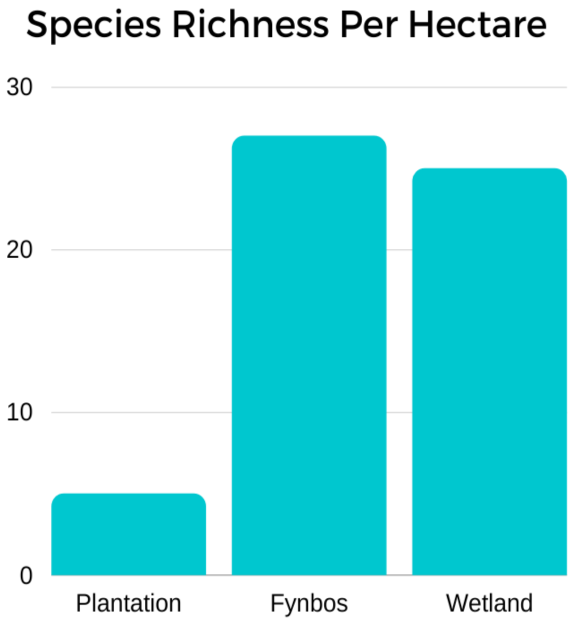
It is crucial to note that no clearing of vegetation has ever occurred in the plantation.



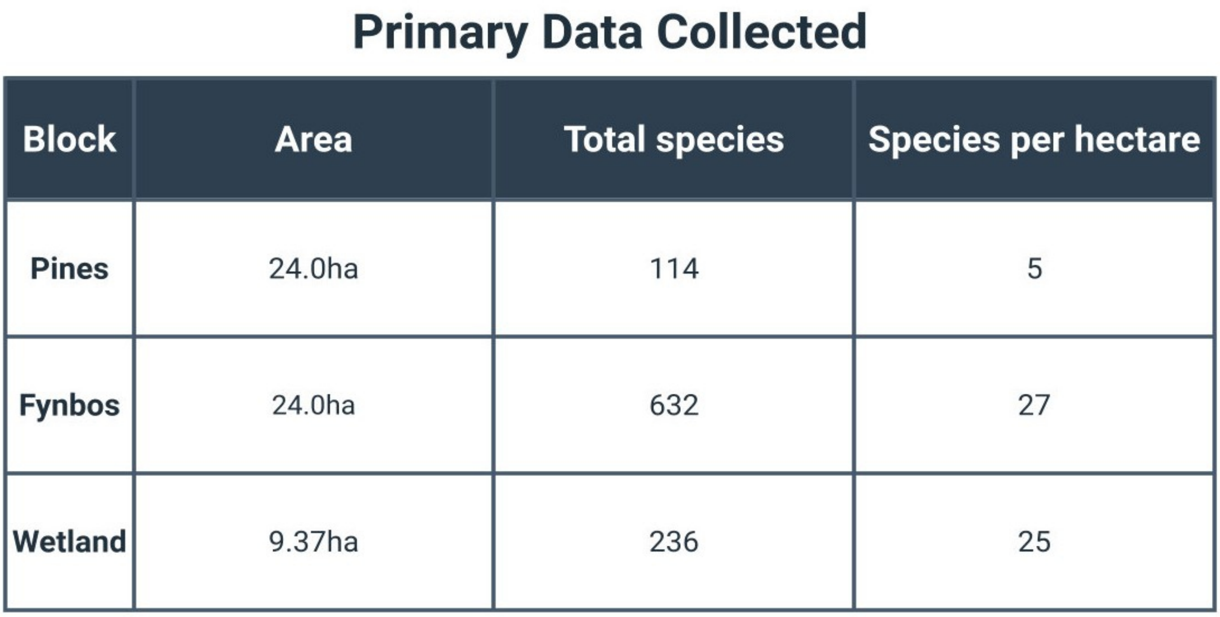
- Fig. 3: Pie chart illustrating species richness per study block (does not account for difference in total area)

Synthesising this data to reflect a more accurate measurement of species per hectare (spp/ha) in each sector provides a clearer understanding of how biodiverse each area truly is.

Upon doing these calculations I found that the Pine block has an average of 5spp/ha. Unsurprisingly the Fynbos block has 27spp/ha and the wetland has 25spp/ha. This is further proof that the wetland is far more biodiverse following the removal of the Pines there, provided that the same area had similar species diversity to the current plantation. The correlation between the state of the Fynbos and wetland to the Pine plantations is clear; it is evident that the Pines lead to a rapid decline in biodiversity.



- Fig. 4: Bar graph illustrating species richness per hectare


Primary Data Collected

Block	Area	Total species	Species per hectare
Pines	24.0ha	114	5
Fynbos	24.0ha	632	27
Wetland	9.37ha	236	25

- Fig. 5: Table illustrating total primary data collected

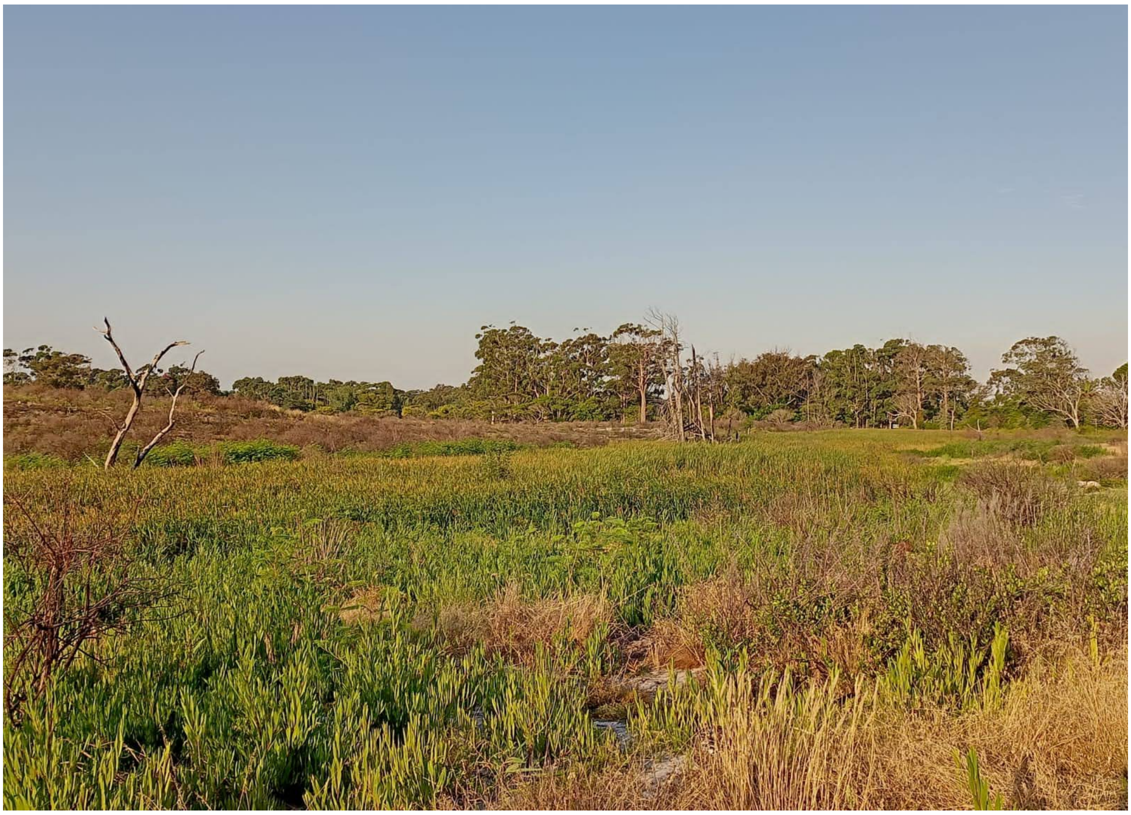
Moreover, in my interview, Prof. Tony Rebelo confirmed that the Pines had destroyed or altered the functionality of the Prinskasteel Wetland while under their occupation. Nonetheless, the wetland has almost completely recovered since their removal in 2016.

This is inferred from both my data of the species return rate in the other 24.0ha Fynbos block and confirmation by Prof. Rebelo, who has intensely studied the area since the late 1990's: "Following removal of the Pines, the lower two thirds [of the wetland] became permanently wet, and the Sedges were replaced by Bulrush: the Sedges (and Ferns) became confined to the edges." said Prof. Rebelo.

He explained that before the Pines were removed, the wetland was completely dried out for most of the year and was even used for Paintball Gun activities.

When asked about the affected biodiversity, he replied: "There were hardly any plants under the Pines... removal of the Pines resulted in significant patchy recovery." He further explained, "[Although] the seedbanks are small and numbers of plants emerging are small, biodiversity is still very high." He noted that because of this, complete restoration is still very much possible.

Replenishing water and reintroducing direct sunlight via the removal of the alien Pines allows the indigenous species to return, despite the negative impacts of the Pines being extremely clear. However, several historical species have had to be reintroduced to some areas of the park, as they were totally lost to the Pines [Poulsen & Rebelo 2021]. This iterates that although it is still possible for the Fynbos and wetlands to recover, the drastic effects of the Pines have not gone unnoticed.



- Fig. 6: Photograph of the Prinskasteel wetland with bulrushes

It is nonetheless important to note that the effects of Pines on biodiversity and water abundance (or rather scarcity) are well-recorded.

In their study; Scott, Maitre, & Fairbanks (1998) deduced that commercial plantations reduced mean stream flow by an estimated 7.8% in South Africa and 6% in the Western Cape alone [Fig. 7b]. Pines use a significant amount water in comparison to all popular plantation crops, including other introduced Australian *Acacia* (Wattle) and *Eucalyptus* (Bluegum) species [Fig. 7a]. This data can be applied to the Prinskasteel Wetland before the Pines were removed and how the water flow has drastically increased following their removal. This has allowed the local ecosystems to regenerate and native species return.

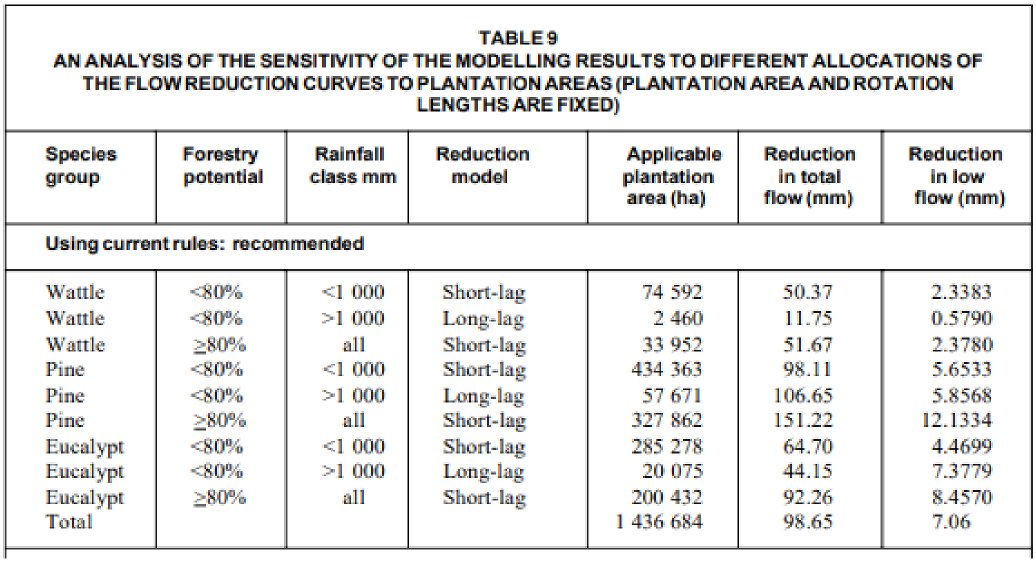


TABLE 9
AN ANALYSIS OF THE SENSITIVITY OF THE MODELLING RESULTS TO DIFFERENT ALLOCATIONS OF THE FLOW REDUCTION CURVES TO PLANTATION AREAS (PLANTATION AREA AND ROTATION LENGTHS ARE FIXED)

Species group	Forestry potential	Rainfall class mm	Reduction model	Applicable plantation area (ha)	Reduction in total flow (mm)	Reduction in low flow (mm)
Using current rules: recommended						
Wattle	<80%	<1 000	Short-lag	74 592	50.37	2.3383
Wattle	<80%	>1 000	Long-lag	2 460	11.75	0.5790
Wattle	≥80%	all	Short-lag	33 952	51.67	2.3780
Pine	<80%	<1 000	Short-lag	434 363	98.11	5.6533
Pine	<80%	>1 000	Long-lag	57 671	106.65	5.8568
Pine	≥80%	all	Short-lag	327 862	151.22	12.1334
Eucalypt	<80%	<1 000	Short-lag	285 278	64.70	4.4699
Eucalypt	<80%	>1 000	Long-lag	20 075	44.15	7.3779
Eucalypt	≥80%	all	Short-lag	200 432	92.26	8.4570
Total				1 436 684	98.65	7.06

- Fig. 7a: Table illustrating the amount of water flow reduction (mm) caused by Pine Plantations in South Africa (Scott et al. 1998)

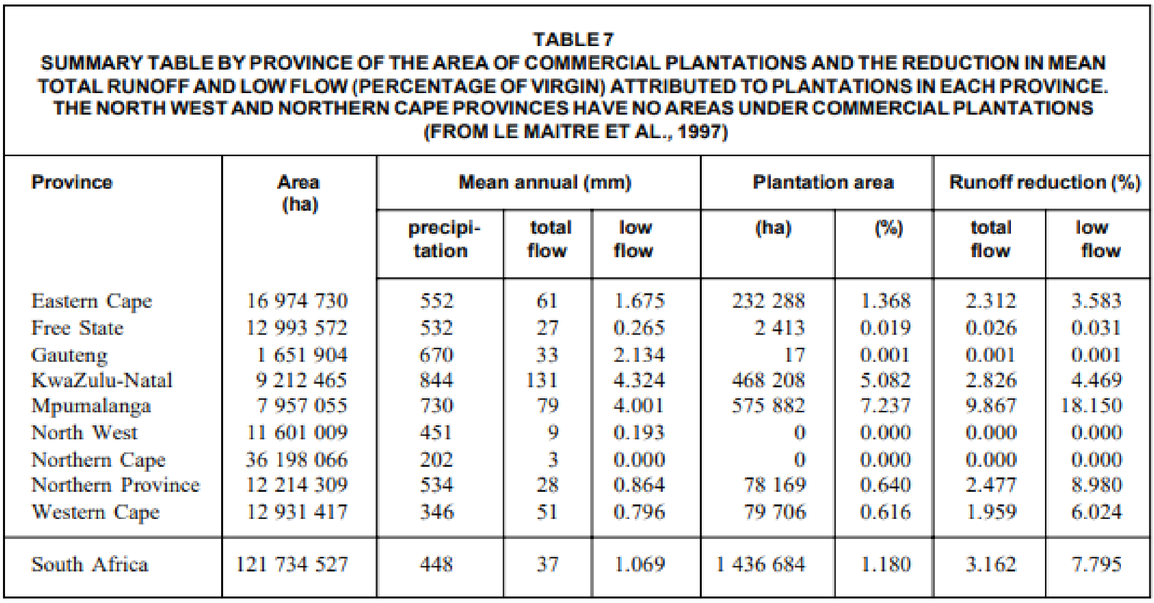


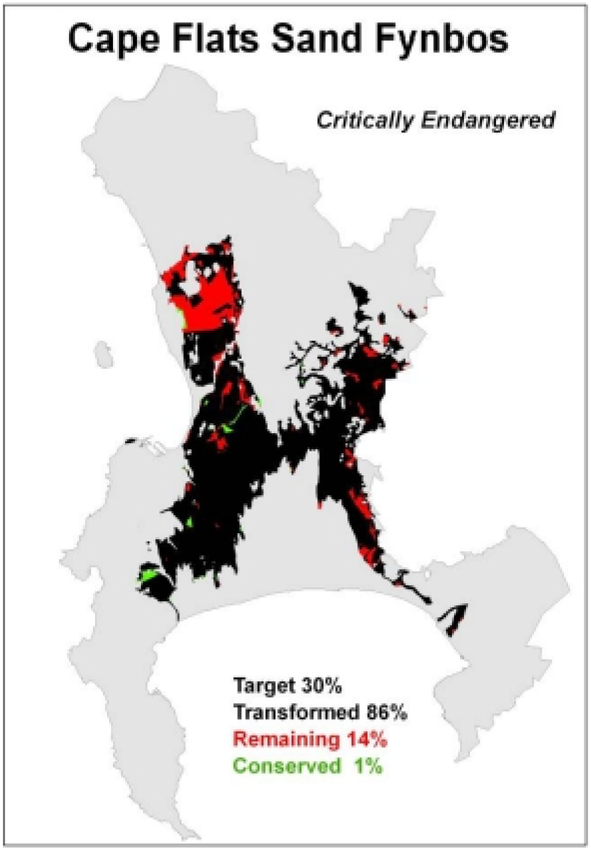
TABLE 7
SUMMARY TABLE BY PROVINCE OF THE AREA OF COMMERCIAL PLANTATIONS AND THE REDUCTION IN MEAN TOTAL RUNOFF AND LOW FLOW (PERCENTAGE OF VIRGIN) ATTRIBUTED TO PLANTATIONS IN EACH PROVINCE. THE NORTH WEST AND NORTHERN CAPE PROVINCES HAVE NO AREAS UNDER COMMERCIAL PLANTATIONS (FROM LE MAITRE ET AL., 1997)

Province	Area (ha)	Mean annual (mm)			Plantation area		Runoff reduction (%)	
		precipi-tation	total flow	low flow	(ha)	(%)	total flow	low flow
Eastern Cape	16 974 730	552	61	1.675	232 288	1.368	2.312	3.583
Free State	12 993 572	532	27	0.265	2 413	0.019	0.026	0.031
Gauteng	1 651 904	670	33	2.134	17	0.001	0.001	0.001
KwaZulu-Natal	9 212 465	844	131	4.324	468 208	5.082	2.826	4.469
Mpumalanga	7 957 055	730	79	4.001	575 882	7.237	9.867	18.150
North West	11 601 009	451	9	0.193	0	0.000	0.000	0.000
Northern Cape	36 198 066	202	3	0.000	0	0.000	0.000	0.000
Northern Province	12 214 309	534	28	0.864	78 169	0.640	2.477	8.980
Western Cape	12 931 417	346	51	0.796	79 706	0.616	1.959	6.024
South Africa	121 734 527	448	37	1.069	1 436 684	1.180	3.162	7.795

- Fig. 7b: Table illustrating the percentage amount of water flow reduction caused by Plantations in South Africa per province (Scott et al. 1998)

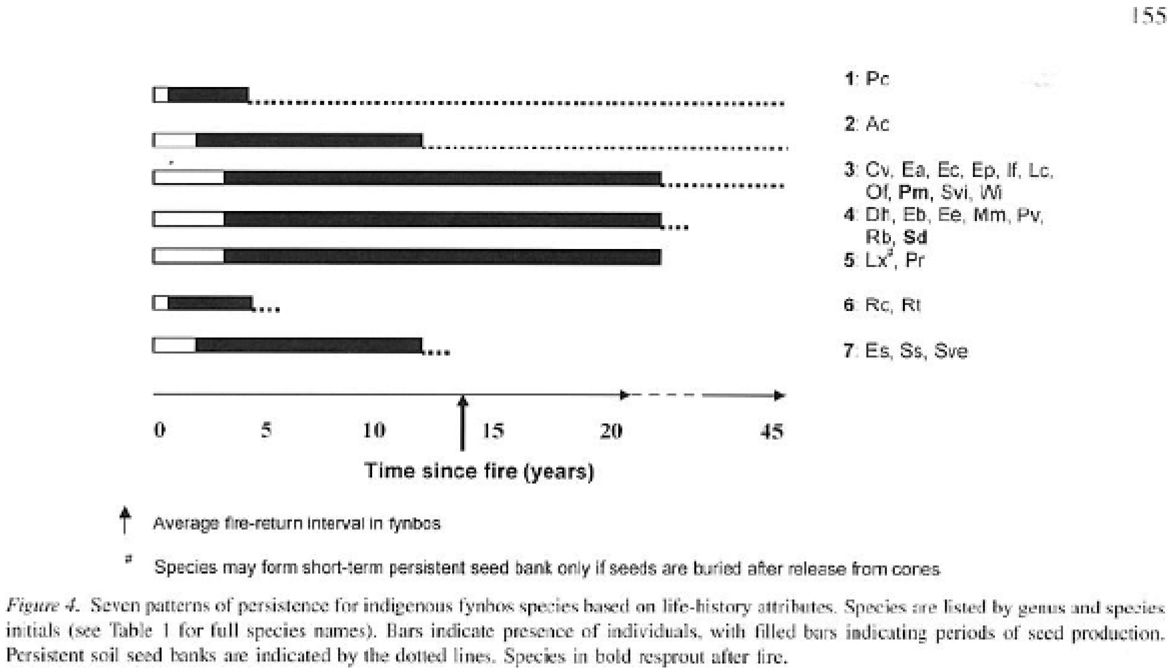
In her article for the Constantiaberg Bulletin (2016), *'Tokai Park debate'*, Adri-Anne Peters highlights the mounting conflict between local Tokai residents, and scientists and conservationists. While conservationists push for the removal of the Pines and therefore the subsequent restoration of the Critically Endangered Cape Flats Sand Fynbos, many residents are instead in favour of keeping the Pines to provide shade for their own recreational activities, even to the detriment of the Fynbos. A copy of this article is attached at the end.

Peters explains that the Tokai Pine plantations were actually planted by Mountains to Oceans (MTO) Forestry specifically to be cut down and harvested again – as they have been for over a century. They are a commercial timber crop with an expiration date (usually harvested every 30 years). They were never intended to be strictly for trivial human activities and personal recreation; which has actually proven to be somewhat selfish in the context of our current environmental extinction crisis.



- Fig 8: Government statistics illustrating the dire situation of the CFSF Lower Tokai Park is the southern-most green area (City of Cape Town 2011)

However, viable seedbanks (natural viable seeds lying dormant in the ground) still exist and the Fynbos will thrive provided that the Pines are removed and fire stimulates these seedbanks before they expire [Poulsen et al. 2021]. This is thought to be roughly 25 years – and even by then as much as a 50% decline in the diversity of said seedbank may have occurred. This is inferred not just by Holmes & Newton in their study *'Patterns of seed persistence in South African Fynbos'* (2004), but also by direct observation of other areas of Tokai Park where plantation removal has already commenced.



↑ Average fire-return interval in fynbos

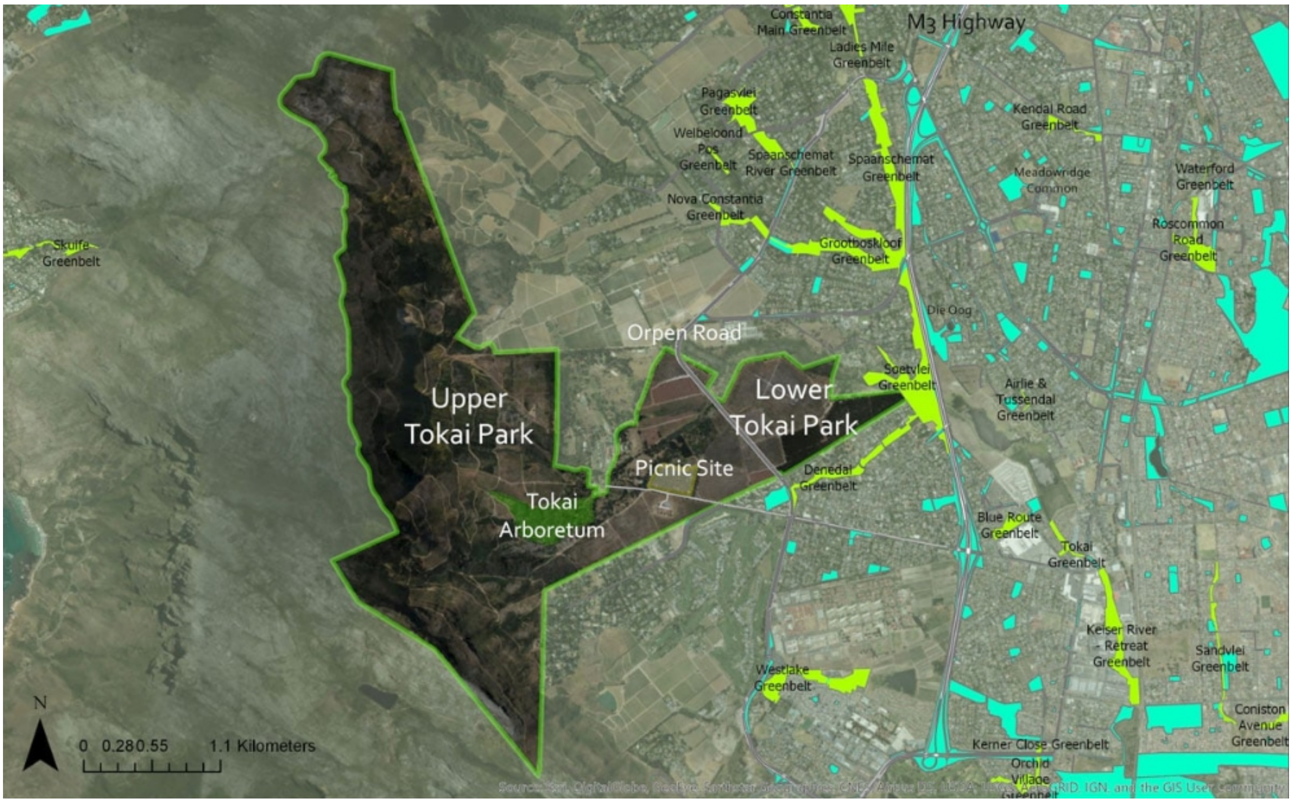
# Species may form short-term persistent seed bank only if seeds are buried after release from cones

Figure 4. Seven patterns of persistence for indigenous fynbos species based on life-history attributes. Species are listed by genus and species initials (see Table 1 for full species names). Bars indicate presence of individuals, with filled bars indicating periods of seed production. Persistent soil seed banks are indicated by the dotted lines. Species in bold resprout after fire.

- Fig. 9: Table illustrating seedbank viability in Fynbos species (Holmes et al. 2004)

Recommendations & Solutions:

The further removal of the Pines needs to commence – and commence as soon as possible at that. We cannot wait until these last remaining Fynbos seedbanks have been destroyed. We can achieve this by educating the community on the local Fynbos and why it is so important to conserve the last of this Critically Endangered vegetation type. The indigenous Fynbos was here long before us and so we should learn to respect it and realise our place in the natural world. This will encourage us to rather strive to protect biodiversity by clearing all invasive alien species, mitigating harmful pollution, and restoring the lost species as best as possible. 'Indigenous trees' can be planted along walkways for park visitors. This way we can remove the Pines and save many threatened species while still being able to enjoy the natural environment in cool and shaded comfort. Alternative nearby greenbelts should also be put use, ensuring that residents can still take part in their own recreational activities with direct access to shade [Fig. 10]. Importantly, we must remain calm and logical in deciding the future of the Tokai plantation so that we can reach the best conclusion for everyone.



- Fig 10: Map of alternative shaded greenbelts that can be used for recreation (yellow) in juxtaposition to the Lower Tokai Park plantation (FOTP 2021)

Conclusion:

It is gathered from the analysis and synthesis of both my primary and secondary data that the hypothesis is correct; I accept it: ***Commercial pine plantations negatively impact biodiversity and wetland functionality at Lower Tokai Park.***

Although there is much conflict between scientists and residents, I have inferred from the data that the Pines have destroyed the biodiverse ecosystems and wiped out many species. They also lead to a greatly reduced water flow rate in the wetland. Despite this it is still possible for Fynbos (seedbanks) and the wetlands to recover – provided that the Pines are swiftly removed and rehabilitation is allowed to take place. It is critical that action must be taken now before the underlying seedbanks further deteriorate.

As a commercial timber crop, the Pines must instead be removed just as planned (and argued for by scientists) in order to prevent further local mass extinctions. Now – more than ever – preventing outright species extinction is significantly more important than human recreation. Cape Town has several alternative shaded greenbelts to explore where Critically Endangered Cape Flats Fynbos biodiversity is not currently threatened [Fig. 10]. After all, Lower Tokai Park is ***'nature reserve'*** and we should strive to protect; just as is implied by that very term. A monoculture Pine plantation can be moved almost anywhere, but an extremely diverse Critically Endangered ecosystem cannot.

"Humans have destroyed and damaged over 95% of the Cape Flats Sand Fynbos; more than half of this in the last 50 years: in our lifetime.

Tokai has gone from being an insignificant plantation to the hope and salvation of hundreds of Fynbos species that used to occur over much of the Cape Flats from Zandvlei to Somerset West, to Kraaifontein and Philadelphia.

Tokai is the last stand for many."

- Prof. Patricia Holmes, Stellenbosch University

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Constantiaberg Bulletin

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Tokai Park debate

By **ADRI-ANN PETERS** . Jul 28, 2016

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A heated discussion about the future of Tokai Park took place at the Alphen Centre on Wednesday July 20.

Botanists and dozens of residents who packed the hall were looking for solutions to the safety versus conservation debate that has recently erupted at Tokai Park.

On one side of the debate there is Parkscape, a public organisation that wants to preserve Tokai Park's recreational use and ensure public interest isn't ignored. On the other side there are botanists and representatives from SANParks and CapeNature who say Tokai is one of the few places left where Cape Flats Sand Fynbos rehabilitation can take place.

Giving a PowerPoint presentation at the centre, Parkscape's Nicky Schmidt said: "The founding nature of the park – one focused on the public's interest – has been lost. The Park's primary objective is not people but biodiversity and revenue."

Parkscape also wanted answers from SANParks on whether the Tokai Cecilia Management Framework would still be adhered to after the early exit of Mountains to Oceans (MTO) Forestry.

According to the framework, MTO was given the rights to harvest the park's 600 hectares of pine plantations over 20 years. Parkscape said the 2015 fires had made that plan uneconomical for MTO so they would now complete the felling ahead of their new exit date in 2018 – seven years earlier than originally planned.

As part of the framework, deforested “transition areas” are rehabilitated with indigenous Fynbos, some of which is Critically Endangered. After the Fynbos has sufficiently reseeded, which can take up to a decade, it is replaced with “non-invasive exotic shade trees”. The concern now is what will happen in the “transition areas”.

At the meeting, Gavin Bell, the southern area manager for SANParks, said the framework would remain in place.

In an email to the Bulletin SANParks’ Merle Collins explained: “The decision to phase out commercial plantations on the Peninsula was not made by SANParks but by the government in 1999,” said Ms Collins.

The trees are not being removed as part of an alien clearing programme; they are being harvested on a commercial basis.

“Tokai (and Cecilia) are commercial plantations established to provide timber. Furthermore, the trees are not being harvested by SANParks but by a private company, MTO Forestry, which was awarded the public tender by the then Department of Water Affairs and Forestry (DWAF) in 2004 for the trees.

“As part of the tender process, MTO Forestry purchased the trees from government and has a 20-year lease with DWAF, in terms of which they harvest the plantation trees. This is a contractually binding, irreversible legal commitment. The clear felling of the plantation compartments is continuing in terms of the MTO and Department of Forestry lease for Tokai and Cecilia plantations and once the trees in a compartment are harvested by MTO Forestry, that land is then transferred to SANParks management as part of Table Mountain National Park (TMNP).”

The questions about how to curb the height of the Fynbos, keeping the areas where it is growing safer for the public and controlled burns, were not as easily answered.

In the presentation, Ms Schmidt showed slides of what had been found among the Fynbos – broken beer bottles, cigarette butts and drug baggies. Ms Schmidt said Parkscape had repeatedly tried to get hold of SANParks to discuss the public’s concerns but had not had any response.

Rupert Koopman, a botanist at Cape Nature, with specific emphasis on Fynbos ecology and plant species in the Western Cape, said: “Actually we are all green people.”

He said that only about five percent of Cape Flats Sand Fynbos, which were once dominant plant species in the Western Cape, are still surviving. At the time when the Tokai Cecilia Framework was created the Fynbos’ levels were at 20 percent. Now it was five percent. He said the Fynbos’ height would level out once the nutrient density of the soil levels dropped.

“Healthy Sand Fynbos does not grow to three metres tall,” he said.

In response to comments that Tokai is also a residential area, Mr Koopman said: “The fact is, we allowed the urban edge to go into the Fynbos.”

Mr Bell said fire was the only legal way to keep Fynbos density under control because the National Environmental Management Act (NEMA) protected Fynbos from pruning.

Anthony Hitchcock, the threatened-species manager at Kirstenbosch, said it could take up to 60 years before the nutrient load levelled out.

“The veld at Tokai will have a relatively high nutrient load after 30 to 60 years without fire and because it was a commercial pine plantation. Future fires will ablate the nitrogen, and the other nutrients usually get leached by the rains. So the current Fynbos is higher in nutrients following the pines, but with time, as the nutrient levels equilibrate within a Fynbos system, the vegetation structure will become more typical. This will take two to three fire cycles, so 20 to 30 years.

“Crucial though is that the up-slope river system and water table does not become polluted with fertiliser and septic tank run-off, so the natural connection up to the mountain is crucial.”

In the meantime, while the Fynbos rehabilitates, Parkscape would like:

- Visible patrolling and security in the area.
- Better education of the public about safety.
- The involvement of neighbourhood watches working with Table Mountain Watch, SANParks, City law enforcement and police.
- Greater visibility in the area – which can be achieved with tall stemmed trees, lower-growing Fynbos, grasslands and much wider paths.

Ms Schmidt said improved fire breaks were needed and it was unacceptable to bring Fynbos, with it concomitant fire risk right to the urban edge. “Aside from the danger to property, there are associated health risks from smoke inhalation,” she said.

She added: “SANParks in the new management plan indicate that the Tokai Cecilia Management Framework needs to be reviewed, and therefore the above needs to be discussed in the consultation and public participation processes, and then included in a revised management framework for the area. This consultation and public participation process should take place as soon as possible and before the remaining section of the plantation is felled.”

The only dissenting botanic voice in the fray was Prof. Eugene Moll.

“It’s time the penny dropped,” he said. “People have a space on this planet as well. The Cape Flats used to be covered in Fynbos but we are not going to get it back. You can’t turn the clock back.”

Mr Hitchcock disagreed and countered: “It all amounts to our moral, value system. What right do we have to knowingly cause extinction of species, whether they be animals such as rhinos, or plants? If we do not place any value on nature and its ecosystems then what values do we have?”

Side bar:

The Constantiaberg Bulletin asked Dr Pat Holmes of the South African National Biodiversity Institute (SANBI) why the rehabilitation taking place at Tokai is so important:

She replied: “There are already 49 species of plants locally extinct, with 13 plant species globally extinct in the City of Cape Town area – the greatest number for any City in the world.

“Already since 1997 the significance of Tokai has rocketed. The national target for Cape Flats Sand Fynbos is 30 percent. The amount left has declined from 20 percent in the 1980's to 14 percent in 2000 to 13 percent in 2016. But the veld in good or fair condition (including Tokai) is less than five percent. Tokai Park – below or east of the picnic site accounts for 20 percent of remaining fair condition veld and is one of only two ‘ecologically viable reserves’ (reserves that in theory are sustainable in the long term without excessive management owing to larger size and connectivity).

“We don’t know how many species will self-restore from the seedbanks until the entire area is cleared and burned. Already we have almost 340 indigenous species recorded. Tokai is unique in that we have a complete inventory of plants collected by William Purcell from the adjacent Bergvliet farm between 1917 and 1919. He recorded over 700 species of plants: so we are almost half way there which is mind boggling as Tokai is a smaller area. Our best scenarios for restoration envisaged about 250 species over the entire area.

“Most of the restoration is passive – the plants came from the seedbank. We have only actively introduced about 25 species: these include species extinct in the wild such as the Whorl Heath (*Erica verticillata*), species that are Critically Endangered such as the Rondevlei Spiderhead (*Serruria foeniculacea*) that was saved from the last plant on earth, some resprouters which have very small seed banks such as the Wynberg Spiderhead, (*Serruria cyanoides*) and some species with aerial seed banks (stored in fireproof cones) that don’t have soil-stored seeds.

“Our problem though is that some of these species are surviving as just a handful of plants. We need to allow them to establish minimum viable populations, which is typically 2 000 to 10 000 plants – otherwise they will be vulnerable to extinction for demographic reasons (small populations are susceptible to diseases, disasters and impacts such as picking).

“If we lose Lower Tokai, this will mean losing one fifth of the area of Cape Flats Sand Fynbos under conservation and many species that are confined to this veld type. And it is not just plants: birds, beetles and goggos and other animals such as chameleons are also returning. A species of Monkey Beetle only ever seen once before in the 1940's has appeared on the Witskollie Sugarbushes at Tokai. Slowly the birds and rodents and insects are returning. The entire ecosystem is re-establishing.

“Humans have destroyed and damaged over 95 percent of Cape Flats Sand Fynbos, more than half of this in the last 50 years: in our lifetime. Tokai has gone from being an insignificant plantation to the hope and salvation of hundreds of Fynbos species that used to occur over much of the Cape Flats from Zandvlei to Somerset West, to Kraaifontein and Philadelphia. Tokai is the last stand for many.”

Constantiaberg Bulletin (Adri-Anne Peters) (2016) *Tokai Park Debate* [Online] Available at: https://www.constantiabergbulletin.co.za/news/tokai-park-debate (Accessed: 3 March 2022)

Interview Addendum

With Professor Tony Rebelo (South African National Biodiversity Institute)

24 February 2022

1. How long have you worked with the ecology and/or conservation of Lower Tokai Park?

Informally, I have visited Tokai Park since the late 1990s when we moved to Bergvliet. Sybil Morris and James Forsyth got me interested in the plants and remnants partly through involving my wife, Prof. Patricia Holmes, in surveys of the remaining flora and potential restoration. Formally, since the Department of Environmental Affairs and Tourism decided that the area should be added to the Table Mountain National Park (then the Cape Peninsula National Park), and especially since 2005 when the restoration began in earnest.

2. When were the Pine trees in or around the Prinskasteel Wetland removed?

There were never Pines in the wetland itself, but it was dried out for most of the year and used for Paintball Gun shoot-outs. It was heavily invaded with Willow, primarily Crack and Pussy Willows. These were removed in the mid 2000's. The edges of the wetlands were dense Pines – *Pinus radiata* plantations. These were removed in 2016, when MTO Forestry tried to pull out of Tokai, after the great 2015 fire.

3. Did these Pines affect the wetland ecology (biodiversity and water level/flow) in any way? Was there a rejuvenation of the wetland flow or "functionality" following the removal of the Pines?

It is not so simple. Removal of the Willows from the wetland resulted in a massive resurgence of Sedges: quite a varied recovery of species. It also changed the “eye” from a winter phenomenon to an all year source, which resulted in the lowest part of the wetland becoming permanently wet – and we hoped suitable for Western Leopard Toads, but it soon became a Bulrush patch. Following removal of the Pines, the lower two thirds became permanently wet, and the Sedges were replaced by Bulrush: the Sedges (and Ferns) became confined to the edges. At the same time, Quinine and Ash started [invading] the wetlands from the upper end.

4. Did the Pines affect biodiversity at all – even after their removal? An increase in biodiversity: was there a return of the natural Fynbos and other local animals following their removal? Any species of note?

There were hardly any plants under the Pines, but odd plants did occur. A fire in the early 2000's – killing the pines – resulted in the recovery of *Psoralea pinnata* and Bracken Fern [species]. There was quite varied indigenous flora on the road edge, especially South of the [wetland]. Removal of the Pines resulted in significant patchy recovery. Not as good as in the other blocks, but with a few species largely confined to the block (e.g. *Wiborgia obcordata*) or most common in the block (e.g. *Salvia africana*, *Brunsvigia orientalis*, etc.), but with some very nice patches of recovery. The reason for the lower recovery is possibly that the Pines were not taken out in one block, but over two separate tranches (the first one illegal; in that MTO had not told SANParks, and so it was halted until a restoration plan was drawn up. But this affected seedling regeneration.

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5. Have longer harvest cycles of the Pines noticeably affected the quality of underlying seedbanks; have some species completely disappeared due to the Pines?

Elsewhere yes. But at Tokai, it is all about 100 years old. Roughly three cycles of 30 years each. It was not expected that seedbanks would survive after 100 years of Pines, but for reasons not quite understood; they have. [Although] the seedbanks are small and numbers of plants emerging are small, biodiversity is still very high. Some guilds are missing (e.g. serotinous species) and some are very low [in numbers] (e.g. re-sprouters). However, fire weeds and early seral species are well represented.

6. If so, is it still worth it to restore and conserve these delicate ecosystems at Lower Tokai Park? Why?

Yes, restoration is possible as the matrix of species is present – even if some are very rare, but they should recover given the chance. The significant number of really threatened species – now low on the Cape Flats – that are still present makes this a very important area. Plus it is a repository for other species now locally extinct, that used to occur in the area. Fortunately, we have Purcell's List from neighbouring Tokai, which comprehensively documents species in [this] veld type. So, species that can be locally saved in this last remnant can easily be determined, even if sometimes they are now [locally] extinct or as far away as Darling. Or, in fact, totally extinct in the wild such as *Erica verticillata* and *E. turgida*. Cape Flats Sand Fynbos is virtually extinct South of the N1, and only Tokai and Blaauwberg allow ecologically viable areas to be conserved of this once most-widespread vegetation type in Cape Town.

7. *Do ecological or prescribed fires/burns aid the recovery of the Fynbos? If yes, how or why do we know? Are these prescribed burns perhaps even essential?

Yes. Fynbos species require fire to regenerate. The above ground vegetation needs to be removed, and the bare soil and fire cues (heat pulse, smoke, bare soil, etc.) are essential for many species to germinate. Fires also greatly reduce the seedbanks of alien weeds (especially invasive Mediterranean Grasses) and also stimulate the invasive alien Wattles and Pines to germinate – allowing them to be controlled. In addition, may Fynbos species only flower immediately after the fire (some fire bulbs and orchids), or in the year or two after the fire (Bulbs and re-sprouters), or in younger veld (Peas and other “fire weeds”). Veld older than 20 years is moribund; hardly anything flowers and the fire risk due to dead fuel becomes very high. Without fire there would be no Fynbos. The restoration fire after [clearing the Pines] stimulates the seedbanks and eliminates the alien grasses. Fire is then required every 10-15 years for regeneration of Fynbos to take place.

8. Is there a plan in place to remove the last remaining stand of Pines?

MTO is obligated to remove the last Pines by 2024. They had wanted to remove them all in 2017, because the area is no longer economically viable, but they were stopped by Parkscape. Plans already exist to restore the area, but it is expected that Parkscape will use dirty tricks to try and stop Pine removal – at least until [enough Pines] die, making the area unsafe for people.

Primary Data Source:

Method used to collect primary data of species diversity per study block:
https://www.inaturalist.org/projects/geography-project-2022

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